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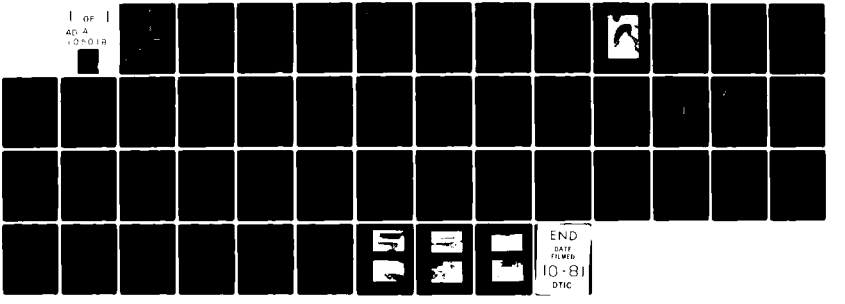

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FREDERICKTOWN CITY DAM

MADISON COUNTY, MISSOURI

MO 30489

DACW43-79-C-0034

(9) Final rept. (11) Sep 79

(10) R. Jeffrey /Kimball James T. /Hockensmith
Kuang Hwei /Chuang

(12) 41

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

Fredericktown City Dam (MO 30489).
Lower Mississippi - St. Francis Basin.
Madison County, Missouri. Phase I Inspection
Report.

Program.

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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER 1979

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

FREDERICKTOWN CITY DAM

MADISON, MISSOURI

MISSOURI INVENTORY NO. 30489

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

L. ROBERT KIMBALL AND ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS
EBENSBURG, PENNSYLVANIA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST, 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Fredericktown City Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of Fredericktown City Dam (MO 30489).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam is classified as unsafe, non-emergency because the structural stability is suspect while passing high spillway flows.

No dam stability analyses are on record which would adequately predict a safe performance of this structure.

Complete evaluation of the dam with respect to a structural stability analysis is not possible without further investigation.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 3 OCT 1979 Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer — 3 OCT 1979 Date

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM	Fredericktown City Dam
STATE LOCATED	Missouri
COUNTY LOCATED	Madison
STREAM	Little St. Francis River
DATE OF INSPECTION	May 1, 1979

Fredericktown City Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The downstream affected area includes Highway 72 and a bridge located 1.8 miles downstream and a dwelling 3.5 miles downstream. The dam is an intermediate size dam since the storage volume is greater than 1,000 acre-feet.

Because of the configuration of the dam with a total overflow spillway section, the dam is capable of controlling the PMF from a hydrologic standpoint. However, spillway capacity is related to the structural adequacy of the dam. If the dam cannot withstand the high loading induced by the PMF then it can be stated that the spillway cannot control the PMF. The total overflow spillway can control approximately 14% of the PMF without overtopping the concrete wingwalls. The rock abutments should be capable of withstanding erosion due to overtopping. An assessment of whether the dam spillway can control the 100 year storm cannot be made without a structural stability analysis. No structural analyses have been performed on the structure and it is uncertain whether the dam can tolerate the loading.

Deficiencies visually observed for Fredericktown City Dam is minor cracking of the concrete wingwalls. The lack of stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" is a deficiency. A warning system and formal safety inspection program should be initiated. These deficiencies should be corrected at the direction of a professional engineer knowledgeable in the design and construction of concrete dams.

It is recommended that the owner take action to correct or control the deficiencies described.

R. JEFFREY KIMBALL, P.E.
L. Robert Kimball & Associates
Vice President, Earth Sciences

JAMES T. HOCKENSMITH
L. Robert Kimball & Associates
Geologist

KUANG HWEI CHUANG, P.E.
L. Robert Kimball & Associates
Hydraulic Engineer

Fredericktown City Dam - Overview

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
FREDERICKTOWN CITY DAM - ID NO. 30489

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 98-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Fredericktown City Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based on available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Fredericktown City Dam is a concrete arch dam with concrete wingwalls at each abutment. The concrete arch is 224 feet long with a radius of 127 feet. The top of the arch section is 4 feet thick and near ogee in shape. The base of the dam is 15 feet thick. The upstream face is vertical and the downstream slope is 1H:10V. The concrete arch is a total overflow section thus the spillway is 224 feet long. Downstream of the concrete arch and on each abutment are five concrete flipbuckets to protect the abutments from erosion and to deflect the overflow toward the center of the dam. The dam is founded on granite. On each abutment, two-foot thick concrete wingwalls are present. The right abutment wingwall is 40 feet long and the left abutment wingwall is 45 feet long. The drainline consists of a 24" cast iron pipe with a sluice gate on the upstream face. The drainline is located near the center of the concrete arch section. Upstream of Fredericktown City Dam are several reservoirs. Eugene Nim's Dam (S-F Scout Ranch Dam) is the largest of the reservoirs. Eugene Nim's Dam is an earthfill dam, approximately 75 feet high.

b. Location. Fredericktown City Dam is located 1.5 miles northwest of Fredericktown, Missouri on the Little St. Francis River. The dam can be located (Section 6, Township 33 North, Range 7 East) on the Fredericktown, Missouri 15 minute U.S.G.S. quadrangle.

c. Size Classification. Fredericktown City Dam is an intermediate size structure (24 feet high, 1185 acre-feet).

d. Hazard Classification. Fredericktown City Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the dam occur. The downstream affected area includes Highway 72 and a bridge located 1.8 miles downstream and a dwelling located 3.5 miles downstream.

e. Ownership. Fredericktown City Dam is owned by the City of Fredericktown. Correspondence should be addressed to:

John R. Bennett
Light & Water Department
City of Fredericktown
P.O. Box 549
Fredericktown, Missouri 63645
314-783-2154

f. Purpose of Dam. Fredericktown City Dam is used for water supply.

g. Design and Construction History. Fredericktown City Dam was designed by Haskins, Regal and Sharp Consulting Engineers and by S.J. Callihan, Structural Engineer. The dam was built in 1954 by Bennett Smith Construction Company. The design drawings and photographs of construction are available in the Light and Water Department of the City of Fredericktown.

h. Normal Operating Procedures. No operating records exist. The lake level is maintained at the spillway crest with excess inflow discharging over the spillway.

1.3 PERTINENT DATA

a. Drainage Area. 60 square miles

b. Discharge at Damsite (cfs).

(1) Maximum known flood at damsite	Unknown
(2) Spillway capacity (to top of dam elevation 735	23376
(3) Drainline	Unknown

c. Elevation (feet) - Based on spillway crest shown on construction drawings.

(1)	Top of dam (spillway wingwall)	735.0
(2)	Spillway crest	725.0
(3)	Normal pool	725.0
(4)	Maximum pool (PMF)	757.1
(5)	Invert on 24" CIP	707.0
(6)	Tailwater (at time of inspection)	707.5

d. Reservoir (feet).

(1)	Length of maximum pool	15,000 feet
(2)	Length of normal pool	11,600 feet

e. Storage (acre-feet).

(1)	Top of dam	3406
(2)	Spillway crest	1185
(3)	Normal pool	1185
(4)	Maximum pool (PMF)	12145

f. Reservoir Surface (acres).

(1)	Top of dam	290
(2)	Spillway crest	158
(3)	Normal pool	158
(4)	Maximum pool	600

g. Dam.

(1)	Type	Concrete arch
(2)	Length	224 feet plus 85 feet(concrete wingwalls)
(3)	Height	24 feet
(4)	Width	4 feet
(5)	Side Slopes - upstream	Vertical
	- downstream	1H:10V
(6)	Zoning	None
(7)	Grout Curtain	None

h. Diversion and Regulating Tunnel.

(1)	Type	24" CI pipe
(2)	Elevation	701.0
(3)	Length	6.5 feet

i. Spillway.

(1)	Type	Uncontrolled over concrete arch
(2)	Length	224 feet
(3)	Crest elevation	725.0
(4)	Upstream channel	Lake
(5)	Downstream channel	Little St. Francis River
(6)	Weir shape	Near ogee

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. The dam was designed by Haskins, Regal and Sharp Consulting Engineers and by S.J. Callihan, Structural Engineer. Construction drawings are available at the City of Fredericktown Light and Water Department offices. No other design data is available.

2.2 CONSTRUCTION. The dam was constructed by Bennett Smith Construction Company in 1954. Photographs on the construction are available in the City of Fredericktown offices. No other construction data is available.

2.3 OPERATION. No operating records exist.

2.4 EVALUATION.

a. Availability. Construction drawings are available at the City of Fredericktown offices. No other data exists.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the guidelines are not on record. This deficiency should be rectified.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The onsite inspection of Fredericktown City Dam was conducted by personnel of L. Robert Kimball and Associates on May 1, 1979. The inspection team consisted of a hydrologist, soils/structural engineer and a geologist. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.

b. Project Geology. Fredericktown Reservoir and dam are underlain by rocks of the Precambrian aged St. Francois Mountains Volcanic Supergroup. These consist mostly of alkali rhyolitic ash flow tufs with minor trachytes.

The Simms Mountain Fault System passes the Fredericktown area on the northeast. Northeast to southeast trending faults have been mapped within five miles of the dam in the deep residual material. The northeastern side of the fault is downthrown an average of 400 to 500 feet. The beds involved range from Precambrain to Ordovician.

c. Dam and Spillway. Visual inspection of the dam indicated the structure was in good condition. From a brief survey conducted during the inspection it was determined that the crest of the dam is even over the entire length. The spillway is formed by the entire concrete arch section of the dam (224 feet long). The reservoir level at the time of inspection was at 725.1. Approximately 0.1 feet of water was discharging over the spillway crest. Because the water was discharging over the spillway, detailed examination of the weir and the downstream slope was impossible. In addition, the vacuum relief ports located in the dam and flip buckets appeared to be in good condition. No deterioration or cracking was noted. The dam itself is founded on granite. The concrete in each of the two abutment wingwalls appeared to be in good condition. On the left wingwall, several cracks were noted in the concrete. At the left abutment of the concrete arch, several trees have begun to grow and in the future may obstruct flow in this portion of the spillway.

d. Appurtenant Structures. A 24" cast iron pipe is located through the dam and serves as a drain line. A sluice gate is located on the upstream portion of the dam. The condition of the drain line was unobserved during the inspection period. During high flows the sluice gate can not be operated.

e. Reservoir Area. No pertinent problems were noted in the reservoir area. The watershed is moderately steep with woodland and farmland.

f. Downstream Channel. Discharges from the spillway enter the Little St. Francis River. The channel of the Little St. Francis River is narrow with several sharp turns.

3.2 EVALUATION. The visual inspection did not reveal any immediate signs of instability. The inspection revealed the concrete was in good condition. The stream basin and downstream face below the tailwater were unobserved because of the water level. In addition, any undercutting of the toe was not determined.

Complete evaluation of the structure cannot be made without a detailed stability analysis or stress analysis with test results of the concrete.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. The reservoir is maintained at the spillway crest. The excess inflow is discharged over the spillway crest. Water is drawn from the reservoir to the water treatment plant on an as-needed basis.

4.2 MAINTENANCE OF DAM. Maintenance of the dam is conducted on an as-needed basis.

4.3 MAINTENANCE OF OPERATING FACILITIES. The operating facilities are maintained on an as-needed basis.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. There is no warning system in effect.

4.5 EVALUATION. Maintenance of the dam and operating facilities are considered good. There is no warning system in effect to warn downstream residents of large spillway discharges or failure of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES.

a. Design Data. There are not hydraulic and hydrological design data available as discussed in Section 2.

b. Experience Data. The drainage area was developed using the U.S.G.S. quadrangle sheet. The lake surface area was determined by planimetering the quadrangle sheet. Surface area - elevations were determined by planimetering various contour lines within the drainage area on the U.S.G.S. quadrangle sheets. The spillway and dam layout was made from surveys conducted during the inspection.

c. Visual Observations. The concrete arch portion of the Fredericktown City Dam acts as an entire overflow section (224 feet long). The spillway weir is near ogee in shape. Water discharges over the spillway and down the downstream face of the dam to a pool at the toe of the dam and into the Little St. Francis River. Ten feet high wingwalls confine flow to the spillway area. If flow over the wingwalls should occur the granite abutments should withstand the flow.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, St. Louis District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydraulic Engineering Center (HEC) U.S. Army Corp of Engineers, Davis California, July, 1978. The major methodologies or key input data for this program are discussed in Appendix B.

To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions:

1. Top of dam was assumed to be elevation 735.0 (top of wingwalls).

2. No flow through the drain line was considered.

3. Because of the total overflow nature of the dam and the spillway capacity being dependent on the structural stability of the dam, the upstream reservoirs were disregarded.

Complete summary sheets of the computer output are presented in Appendix B. To facilitate review, the major results of the overtopping analysis are presented below:

Peak Inflow	178116 cfs
Spillway Capacity	23376 cfs (top of dam)

Ratio of PMF	Maximum Reservoir Water Surface	Maximum Depth Over Dam (concrete spillway)	Maximum Outflow, cfs	Duration of Overtopping, hours
.10	732.74	0.00	15932	0.00
.50	746.18	11.18	82352	7.75
1.00	757.13	22.13	163316	13.00

The Corps of Engineers Spillway Design Flood for a high hazard-intermediate size dam is the PMF. The spillway is capable of controlling approximately 14% of the PMF without overtopping the spillway wingwalls. However the granite abutments should be able to resist erosion due to overtopping, provided the structure can withstand the overtopping from a structural standpoint. An assessment of whether the spillway can control the 100 year storm connot be made without a structural stability analysis.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations did not reveal any signs of immediate instability. The dam appeared to be in good condition. No cracking or deterioration of the concrete was noted. However, the upstream face was obscured because of the high water level and the downstream face was partially obscured because of flow over the spillway. The foundation rock appears to be competent but the characteristics of the foundation/concrete contact is unknown because of the tailwater. The wingwalls appeared to be in good condition with the exception of several cracks on the left wingwall.

b. Design and Construction Data. Construction drawings were available at the city office. These construction show structural details on all major components of the dam. No testing of the concrete was performed. No stability analyses of the dam have been conducted. No design reports exist. Stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operating records are kept on the structure.

d. Post Construction Changes. No post construction changes have been made.

e. Seismic Stability. The dam is located in seismic zone 2, to which the guidelines assign a "moderate" damage potential. No seismic stability analysis has been conducted.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT.

a. Safety. The visual observations, review of available data, hydrologic calculations and past operational performance indicate that Fredericktown City Dam's spillway is inadequate. The spillway is capable of controlling approximately 14% of the PMF. However, because of the total overflow nature of the dam, the spillway capacity is dependent on the structural stability of the dam.

The dam appears to be in good condition. The concrete appeared to be in good condition with no cracking or deterioration noted in the dam. It must be noted that the upstream face was not observable because of the high lake level. The downstream face was partially obscured because of the spillway discharge. The structural stability of the structure is unknown. Stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Complete assessment of the structural stability of the structure cannot be made because of the limited design data and no stability, stress or seepage analyses comparable to the "Recommended Guidelines for Safety Inspections of Dams".

c. Urgency. The deficiencies described herein are serious and corrective actions listed below should be initiated promptly.

d. Need for Phase II. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. A detailed stability analysis should be conducted by a registered professional engineer knowledgeable in dam design. The analysis should be conducted using all critical loading conditions.

b. All gate operating mechanisms should be exercised and lubricated at regular intervals.

c. Insititue a formal inspection program to be conducted at regular intervals.

d. Institute a formal warning system to warn downstream residences of high spillway discharges or failure of the dam.

DRAWINGS

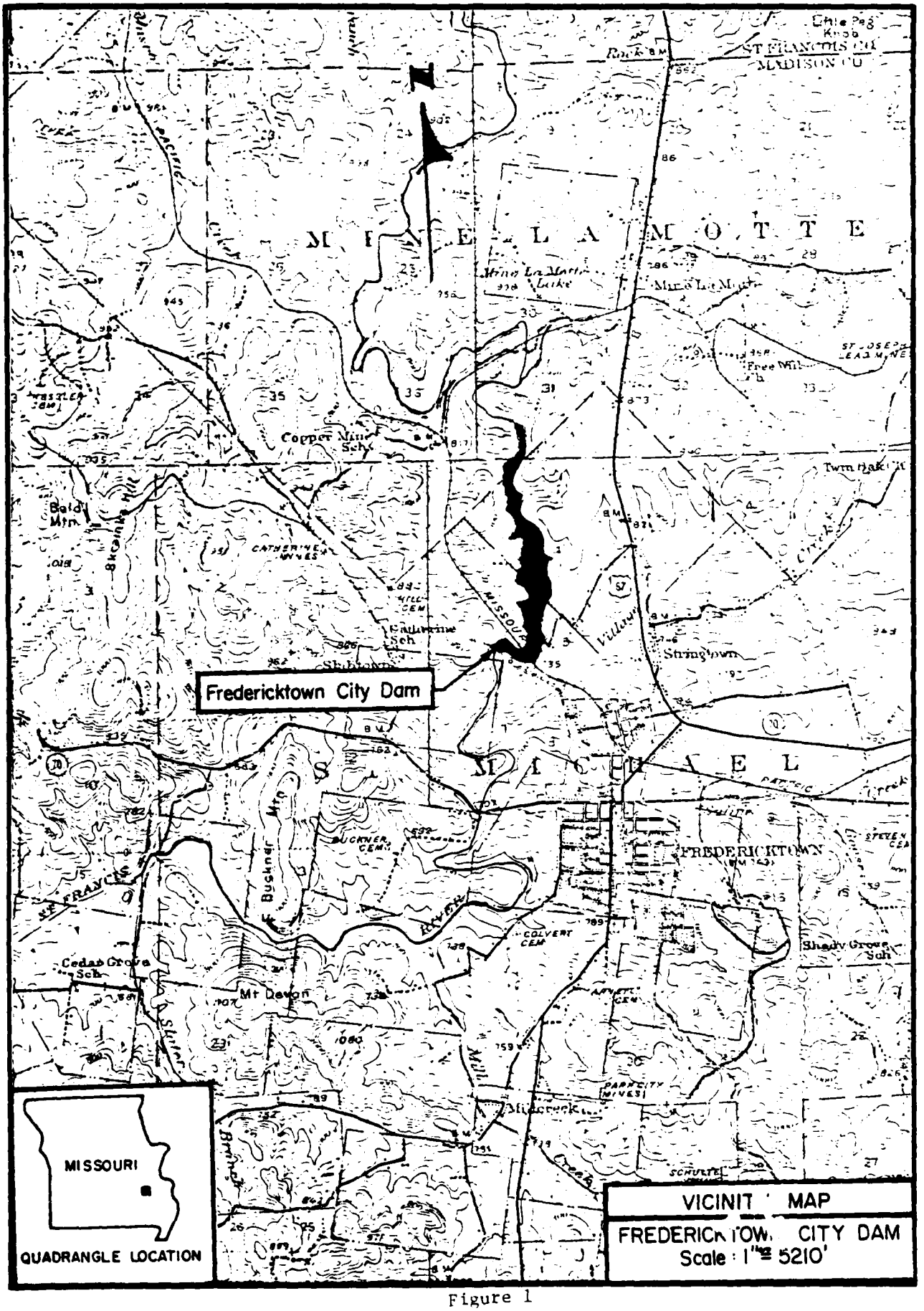
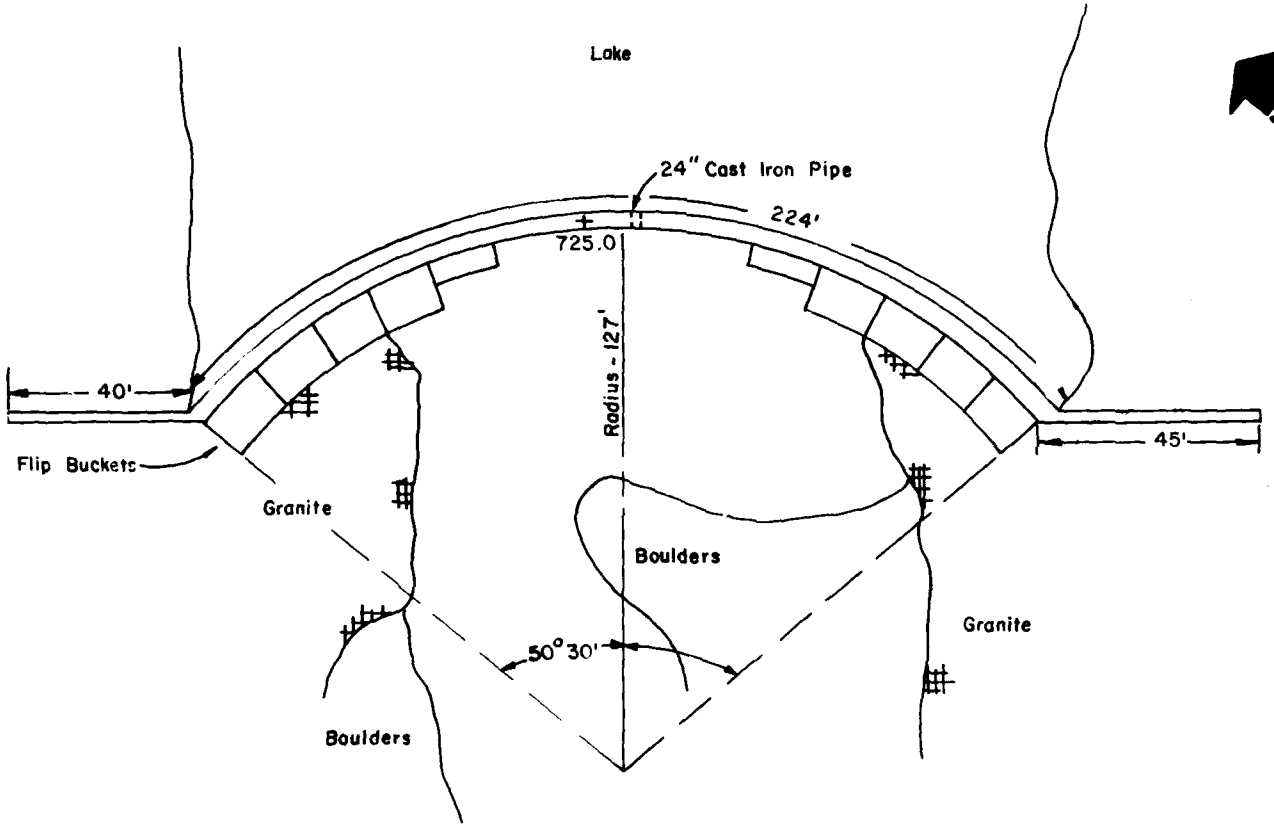

Fredericktown City Dam
MISSOURI
QUADRANGLE LOCATION
VICINITY MAP
FREDERICKTOWN CITY DAM
Scale: 1" = 5210'
FREDERICKTOWN
Mine La Motte
Copper Mine Sch
Bald Mtn
Catherine Sch
Stringtown
Bushner Mtn
Cedar Grove Sch
Mt Devon
Shady Grove Sch
Twin Lakes
St Joseph Lead Mine

Figure 1



PLAN

FREDERICKTOWN CITY DAM
Scale: 1" = 40'

Figure 2

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 48 hour storm duration is assumed with total depth distributed over 6 hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6 hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6 hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillways, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillways, and top of dam are defined by elevation-discharge curves.

Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME FREDRICKTOWN CITY DAM
I.D. NUMBER 30489
SHEET NO. 1 OF 2
BY DTM DATE 9-7-79 *

FREDRICKTOWN CITY DAM

DRAINAGE AREA

AREA = 60 mi² (ST. LOUIS DISTRICT C.O.E.)

UNIT HYDROGRAPH PARAMETERS

KIRPICH METHOD:

t_R = 4.58 HRS. LAG (L) = 0.6 t_R = 2.75 HRS
WHERE LENGTH = 63,000 FT.
HEIGHT = 375 FT.
(FROM, TIME OF CONCENTRATION NOMOGRAPH, KENTUCKY BUREAU OF HIGHWAYS)

CURVE NUMBER METHOD:

$$LAG(L) = \frac{l^{0.8}(S+1)^{0.7}}{1900\, Y^{0.5}} = \frac{(63000)^{0.8}(2.49)^{0.7}}{1900\,(3.0)^{0.5}}$$

$$= \frac{(6910)(1.89)}{3291} = 4.0 \text{ HRS.}$$

WHERE l = GREATEST FLOW LENGTH IN FEET

$S = \frac{1000}{CN} - 10$ AND CN = SCS CURVE NUMBER
Y = AVERAGE SLOPE

LOSS RATE AND BASE FLOW PARAMETERS

STRTL = 1 INCH
CNSTL = 87* SCS CURVE NUMBER (SOIL GROUP C)
STRTQ = 1.5 cfs/mi²
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.5

* UTILIZED ANTECEDENT MOISTURE CONDITION III

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME FREDERICKTOWN CITY DAM
I.D. NUMBER 30+89
SHEET NO. 2 OF 2
BY DTM DATE 9-7-79

PROBABLE MAXIMUM STORM

FROM H.R. NO. 33

P.M.P. INDEX RAINFALL (ZONE 7) = 26.5 INCHES
$R_6 = 84\%$, $R_{12} = 102\%$, $R_{24} = 112\%$, $R_{48} = 123\%$

ELEVATION-AREA-CAPACITY RELATIONSHIP

SPILLWAY CREST ELEV. = 725', AREA = 158 ACRES
INITIAL STORAGE = 1183 AC. FT
FROM ST. LOUIS DISTRICT C.O.E. AND U.S.G.S. 7.5-MIN. QUADS.

ELEV. 740', AREA = 352 ACRES

FROM CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1). DAM SAFETY VERSION (USERS MANUAL)

$H = 3V/A = 3(1183)/158 = 22.5$ FT.

ELEV. WHERE CAPACITY EQUALS ZERO
725' - 22.5' = 702.5'

AREA (AC)	0	158	195	250	300	350
ELEV. (FT.)	702.5	725	728	732	736	739

DISCHARGE PARAMETERS

LOCATION	WEIR LENGTH	TYPE	DISCHARGE COEFF.
SPILLWAY	224'	(FLAT, CONCRETE)	3.3
DAM (OVERTOP)	95'	BROAD CREST	2.9

FROM: $Q = CLH^{3/2}$

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF FREDRICKTOWN CITY DAM
    3          A3      RATIOS OF PMF ROUTED THROUGH THE RESERVOIR  (MISSOURI  30489)
    4          B   192       0      15       0       0       0       0       0       0       0
    5          B1    5
    6          J     1       6       1
    7          J1   .1      .2      .3      .4      .5       1
    8          K     0       1                                       1
    9          K1      INFLOW TO THE RESERVOIR
   10          M     1       2      60              60       1                               1
   11          P           26.5      84     102     112     123
   12          T                                                   -1     -87
   13          W2          2.75
   14          X   -1.5    -.05     2.5
   15          K     1       2                                       1
   16          K1      ROUTE THROUGH THE RESERVOIR
   17          Y                                       1       1
   18          Y1    1                                                 -725
   19          SA    0     158     195     250     300     350
   20          SE 702.6     725     728     732     736     740
   21          SS   725     224     3.3     1.5
   22          SD   735     2.9     1.5      95
   23          K    99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/09/17.
TIME= 06.25.51.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF FREDRICKTOWN CITY DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI 304891

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
192	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 1.00

BTS

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO THE RESERVOIR

ISTAQ	ICOMP	ICON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	60.00	0.00	60.00	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.50	84.00	102.00	112.00	123.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 WEINESS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 2.75

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.50

UNIT HYDROGRAPH 57 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 2.75 VOL= 1.00

263.	823.	1559.	2492.	3684.	5151.	6789.	8191.	9176.	9789.
10030.	10030.	9789.	9246.	8629.	7928.	7069.	6062.	5116.	4358.
3771.	3259.	2821.	2501.	2181.	1901.	1639.	1411.	1236.	1065.
933.	802.	699.	602.	521.	456.	393.	345.	297.	261.
226.	196.	170.	146.	128.	111.	100.	90.	79.	69.
58.	48.	39.	31.	22.	13.	4.			

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.00	0.00	.00	82.	1.02	.15	97	.04	.04	.01	1738.
1.01	.30	2	.00	0.00	.00	75.	1.02	.30	98	.04	.04	.01	1652.
1.01	.45	3	.00	0.00	.00	68.	1.02	.45	99	.04	.04	.01	1605.
1.01	1.00	4	.00	0.00	.00	62.	1.02	1.00	100	.04	.04	.01	1603.
1.01	1.15	5	.00	0.00	.00	57.	1.02	1.15	101	.04	.04	.01	1649.
1.01	1.30	6	.00	0.00	.00	52.	1.02	1.30	102	.04	.04	.01	1756.
1.01	1.45	7	.00	0.00	.00	47.	1.02	1.45	103	.04	.04	.01	1923.
1.01	2.00	8	.00	0.00	.00	43.	1.02	2.00	104	.04	.04	.00	2146.
1.01	2.15	9	.00	0.00	.00	39.	1.02	2.15	105	.04	.04	.00	2407.
1.01	2.30	10	.00	0.00	.00	36.	1.02	2.30	106	.04	.04	.00	2695.
1.01	2.45	11	.00	0.00	.00	33.	1.02	2.45	107	.04	.04	.00	2998.
1.01	3.00	12	.00	0.00	.00	30.	1.02	3.00	108	.04	.04	.00	3305.
1.01	3.15	13	.00	0.00	.00	27.	1.02	3.15	109	.04	.04	.00	3611.
1.01	3.30	14	.00	0.00	.00	25.	1.02	3.30	110	.04	.04	.00	3902.
1.01	3.45	15	.00	0.00	.00	23.	1.02	3.45	111	.04	.04	.00	4175.
1.01	4.00	16	.00	0.00	.00	21.	1.02	4.00	112	.04	.04	.00	4428.
1.01	4.15	17	.00	0.00	.00	19.	1.02	4.15	113	.04	.04	.00	4656.
1.01	4.30	18	.00	0.00	.00	17.	1.02	4.30	114	.04	.04	.00	4852.
1.01	4.45	19	.00	0.00	.00	16.	1.02	4.45	115	.04	.04	.00	5020.
1.01	5.00	20	.00	0.00	.00	14.	1.02	5.00	116	.04	.04	.00	5163.
1.01	5.15	21	.00	0.00	.00	13.	1.02	5.15	117	.04	.04	.00	5289.
1.01	5.30	22	.00	0.00	.00	12.	1.02	5.30	118	.04	.04	.00	5399.
1.01	5.45	23	.00	0.00	.00	11.	1.02	5.45	119	.04	.04	.00	5496.
1.01	6.00	24	.00	0.00	.00	10.	1.02	6.00	120	.04	.04	.00	5584.
1.01	6.15	25	.02	0.00	.02	9.	1.02	6.15	121	.20	.18	.02	5700.

1.01	6.30	26	.02	0.00	.02	8.	1.02	6.30	122	.20	.18	.01	5889.
1.01	6.45	27	.02	0.00	.02	8.	1.02	6.45	123	.20	.18	.01	6175.
1.01	7.00	28	.02	0.00	.02	7.	1.02	7.00	124	.20	.19	.01	6588.
1.01	7.15	29	.02	0.00	.02	6.	1.02	7.15	125	.20	.19	.01	7167.
1.01	7.30	30	.02	0.00	.02	6.	1.02	7.30	126	.20	.19	.01	7953.
1.01	7.45	31	.02	0.00	.02	5.	1.02	7.45	127	.20	.19	.01	8973.
1.01	8.00	32	.02	0.00	.02	5.	1.02	8.00	128	.20	.19	.01	10195.
1.01	8.15	33	.02	0.00	.02	4.	1.02	8.15	129	.20	.19	.01	11560.
1.01	8.30	34	.02	.00	.02	4.	1.02	8.30	130	.20	.19	.01	13016.
1.01	8.45	35	.02	.00	.02	4.	1.02	8.45	131	.20	.19	.01	14511.
1.01	9.00	36	.02	.00	.02	4.	1.02	9.00	132	.20	.19	.01	16010.
1.01	9.15	37	.02	.00	.02	4.	1.02	9.15	133	.20	.19	.01	17479.
1.01	9.30	38	.02	.00	.02	6.	1.02	9.30	134	.20	.19	.01	18874.
1.01	9.45	39	.02	.00	.02	9.	1.02	9.45	135	.20	.19	.01	20184.
1.01	10.00	40	.02	.00	.02	15.	1.02	10.00	136	.20	.19	.01	21395.
1.01	10.15	41	.02	.00	.02	23.	1.02	10.15	137	.20	.19	.01	22485.
1.01	10.30	42	.02	.00	.02	34.	1.02	10.30	138	.20	.19	.01	23432.
1.01	10.45	43	.02	.00	.02	50.	1.02	10.45	139	.20	.19	.01	24243.
1.01	11.00	44	.02	.00	.02	69.	1.02	11.00	140	.20	.19	.01	24945.
1.01	11.15	45	.02	.00	.02	93.	1.02	11.15	141	.20	.19	.01	25560.
1.01	11.30	46	.02	.00	.01	121.	1.02	11.30	142	.20	.19	.00	26100.
1.01	11.45	47	.02	.01	.01	154.	1.02	11.45	143	.20	.19	.00	26575.
1.01	12.00	48	.02	.01	.01	189.	1.02	12.00	144	.20	.19	.00	27001.
1.01	12.15	49	.05	.02	.04	231.	1.02	12.15	145	.56	.54	.01	27471.
1.01	12.30	50	.05	.02	.04	282.	1.02	12.30	146	.56	.55	.01	28094.
1.01	12.45	51	.05	.02	.03	345.	1.02	12.45	147	.56	.55	.01	28935.
1.01	13.00	52	.05	.02	.03	423.	1.02	13.00	148	.56	.55	.01	30069.
1.01	13.15	53	.07	.03	.04	521.	1.02	13.15	149	.67	.66	.01	31624.
1.01	13.30	54	.07	.03	.03	645.	1.02	13.30	150	.67	.66	.01	33729.
1.01	13.45	55	.07	.03	.03	800.	1.02	13.45	151	.67	.66	.01	36472.
1.01	14.00	56	.07	.04	.03	987.	1.02	14.00	152	.67	.66	.01	39792.
1.01	14.15	57	.08	.05	.03	1208.	1.02	14.15	153	.83	.83	.01	43621.
1.01	14.30	58	.08	.05	.03	1463.	1.02	14.30	154	.83	.83	.01	47909.
1.01	14.45	59	.08	.05	.03	1753.	1.02	14.45	155	.83	.83	.01	52576.
1.01	15.00	60	.08	.05	.03	2076.	1.02	15.00	156	.83	.83	.01	57547.
1.01	15.15	61	.08	.06	.03	2429.	1.02	15.15	157	.85	.84	.01	62737.
1.01	15.30	62	.17	.12	.05	2826.	1.02	15.30	158	1.69	1.68	.01	68272.
1.01	15.45	63	.47	.35	.11	3343.	1.02	15.45	159	4.74	4.72	.02	75161.
1.01	16.00	64	.12	.09	.02	3987.	1.02	16.00	160	1.18	1.18	.00	83435.
1.01	16.15	65	.08	.06	.01	4715.	1.02	16.15	161	.78	.78	.00	92483.
1.01	16.30	66	.08	.06	.01	5526.	1.02	16.30	162	.78	.78	.00	102237.
1.01	16.45	67	.08	.06	.01	6432.	1.02	16.45	163	.78	.78	.00	112897.
1.01	17.00	68	.08	.06	.01	7431.	1.02	17.00	164	.78	.78	.00	124466.
1.01	17.15	69	.06	.05	.01	8460.	1.02	17.15	165	.61	.61	.00	136135.
1.01	17.30	70	.06	.05	.01	9376.	1.02	17.30	166	.61	.61	.00	146027.

1.01	17.45	71	.06	.05	.01	10109.	1.02	17.45	167	.61	.61	.00	153321.
1.01	18.00	72	.06	.05	.01	10663.	1.02	18.00	168	.61	.61	.00	158154.
1.01	18.15	73	.01	.01	.00	11029.	1.02	18.15	169	.07	.07	.00	160481.
1.01	18.30	74	.01	.01	.00	11225.	1.02	18.30	170	.07	.07	.00	160622.
1.01	18.45	75	.01	.01	.00	11240.	1.02	18.45	171	.07	.07	.00	158494.
1.01	19.00	76	.01	.01	.00	11067.	1.02	19.00	172	.07	.07	.00	154054.
1.01	19.15	77	.01	.01	.00	10764.	1.02	19.15	173	.07	.07	.00	148146.
1.01	19.30	78	.01	.01	.00	10326.	1.02	19.30	174	.07	.07	.00	140698.
1.01	19.45	79	.01	.01	.00	9729.	1.02	19.45	175	.07	.07	.00	131430.
1.01	20.00	80	.01	.01	.00	9002.	1.02	20.00	176	.07	.07	.00	120726.
1.01	20.15	81	.01	.01	.00	8239.	1.02	20.15	177	.07	.07	.00	109807.
1.01	20.30	82	.01	.01	.00	7505.	1.02	20.30	178	.07	.07	.00	99496.
1.01	20.45	83	.01	.01	.00	6813.	1.02	20.45	179	.07	.07	.00	89911.
1.01	21.00	84	.01	.01	.00	6148.	1.02	21.00	180	.07	.07	.00	80820.
1.01	21.15	85	.01	.01	.00	5525.	1.02	21.15	181	.07	.07	.00	72387.
1.01	21.30	86	.01	.01	.00	4966.	1.02	21.30	182	.07	.07	.00	64872.
1.01	21.45	87	.01	.01	.00	4445.	1.02	21.45	183	.07	.07	.00	57902.
1.01	22.00	88	.01	.01	.00	3971.	1.02	22.00	184	.07	.07	.00	51582.
1.01	22.15	89	.01	.01	.00	3545.	1.02	22.15	185	.07	.07	.00	45919.
1.01	22.30	90	.01	.01	.00	3180.	1.02	22.30	186	.07	.07	.00	41058.
1.01	22.45	91	.01	.01	.00	2875.	1.02	22.45	187	.07	.07	.00	36992.
1.01	23.00	92	.01	.01	.00	2610.	1.02	23.00	188	.07	.07	.00	33448.
1.01	23.15	93	.01	.01	.00	2383.	1.02	23.15	189	.07	.07	.00	30421.
1.01	23.30	94	.01	.01	.00	2184.	1.02	23.30	190	.07	.07	.00	27749.
1.01	23.45	95	.01	.01	.00	2013.	1.02	23.45	191	.07	.07	.00	25466.
1.02	0.00	96	.01	.01	.00	1861.	1.03	0.00	192	.07	.07	.00	23439.
									SUM	32.60	30.87	1.73	4554491.
										(828.)(	784.)(	44.)(*********

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	160622.	119915.	44827.	23660.	4542734.
CMS	4548.	3396.	1269.	670.	128636.
INCHES		18.59	27.80	29.35	29.35
MM		472.22	706.11	745.38	745.38
AC-FT		59462.	88912.	93858.	93858.
THOUS CU M		73345.	109672.	115772.	115772.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16062.	11992.	4483.	2366.	454273.
CMS	455.	340.	127.	67.	12864.
INCHES		1.86	2.78	2.93	2.93
MM		47.22	70.61	74.54	74.54
AC-FT		5946.	8891.	9386.	9386.
THOUS CU M		7335.	10967.	11577.	11577.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	32124.	23983.	8965.	4732.	908547.
CMS	910.	679.	254.	134.	25727.
INCHES		3.72	5.56	5.87	5.87
MM		94.44	141.22	149.08	149.08
AC-FT		11892.	17782.	18772.	18772.
THOUS CU M		14669.	21934.	23154.	23154.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	48187.	35975.	13448.	7098.	1362820.
CMS	1364.	1019.	381.	201.	38591.
INCHES		5.58	8.34	8.80	8.80
MM		141.67	211.83	223.62	223.62
AC-FT		17839.	26674.	28157.	28157.
THOUS CU M		22004.	32902.	34732.	34732.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	64249.	47966.	17931.	9464.	1817094.
CMS	1819.	1358.	508.	268.	51454.
INCHES		6.44	11.12	11.74	11.74
MM		188.89	282.44	298.15	298.15
AC-FT		23785.	35565.	37543.	37543.
THOUS CU M		29338.	43869.	46309.	46309.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	80311.	59958.	22413.	11830.	2271367.
CMS	2274.	1698.	635.	335.	64318.
INCHES		9.30	13.90	14.67	14.67
MM		236.11	353.05	372.69	372.69
AC-FT		29731.	44456.	46929.	46929.
THOUS CU M		36673.	54836.	57886.	57886.

B-12

[illegible] APPALACHIA [illegible] FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	166622.	115915.	44827.	23660.	4542734.
CMS	4548.	3326.	1269.	670.	128636.
INCHES		15.57	27.80	29.35	29.35
MM		397.22	706.11	745.38	745.38
AC-FT		92462.	88212.	93858.	93858.
THOUS CU M		73345.	109672.	115772.	115772.

HYDROGRAPH ROUTING

ROUTE THROUGH THE RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-725.	0

SURFACE AREA=	0.	158.	195.	250.	300.	350.
CAPACITY=	0.	1185.	1714.	2601.	3700.	4998.
ELEVATION=	703.	725.	728.	732.	736.	740.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CARLA	EXPL
725.0	224.0	3.3	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
735.0	2.9	1.5	95.

STATION 2, PLAN 1, RATIO 1

PEAK OUTFLOW IS 14663. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14663.	11489.	4262.	2228.	427748.
CMS	415.	325.	121.	63.	12112.
INCHES		1.78	2.64	2.76	2.76
MM		45.24	67.13	70.19	70.19
AC-FT		5697.	8453.	8838.	8838.
THOUS CU M		7027.	10427.	10901.	10901.

STATION 2, PLAN 1, RATIO 2

PEAK OUTFLOW IS 29781. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	29781.	23104.	8600.	4507.	865329.
CMS	843.	654.	244.	128.	24503.
INCHES		3.58	5.33	5.59	5.59
MM		90.98	135.46	141.99	141.99
AC-FT		11457.	17057.	17879.	17879.
THOUS CU M		14131.	21040.	22053.	22053.

STATION 2, PLAN 1, RATIO 3

PEAK OUTFLOW IS 45130. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	45130.	34808.	12949.	6794.	1304513.
CMS	1278.	986.	367.	192.	36940.
INCHES		5.40	8.03	8.43	8.43
MM		137.07	203.96	214.05	214.05
AC-FT		17260.	25683.	26953.	26953.
THOUS CU M		21290.	31680.	33246.	33246.

STATION 2, PLAN 1, RATIO 4

PEAK OUTFLOW IS 60345. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	60345.	46609.	17305.	9087.	1744642.
CMS	1709.	1320.	490.	257.	49403.
INCHES		7.23	10.73	11.27	11.27
MM		183.55	272.58	286.27	286.27
AC-FT		23112.	34321.	36046.	36046.
THOUS CU M		28508.	42337.	44462.	44462.

STATION 2, PLAN 1, RATIO 5

PEAK OUTFLOW IS 75481. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	75481.	58404.	21667.	11383.	2185514.
CMS	2137.	1654.	614.	322.	61887.
INCHES		9.05	13.44	14.12	14.12
MM		229.99	341.30	358.61	358.61
AC-FT		28961.	42976.	45155.	45155.
THOUS CU M		35722.	53010.	55698.	55698.

STATION 2, PLAN 1, RATIO 6

PEAK OUTFLOW IS 150256. AT TIME 43.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	150256.	117019.	43550.	22906.	4398034.
CMS	4255.	3314.	1233.	649.	124538.
INCHES		18.14	27.01	28.41	28.41
MM		460.82	686.00	721.64	721.64
AC-FT		58026.	86381.	90868.	90868.
THOUS CU M		71574.	106549.	112085.	112085.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	60.00	1	16062.	32124.	48187.	64249.	80311.	160622.
		(155.40)		(454.83)(	909.66)(	1364.50)(	1819.33)(	2274.16)(	4548.32)(
ROUTED TO	2	60.00	1	14663.	29781.	45130.	60345.	75481.	150256.
		(155.40)		(415.20)(	843.31)(	1277.93)(	1708.79)(	2137.37)(	4254.76)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

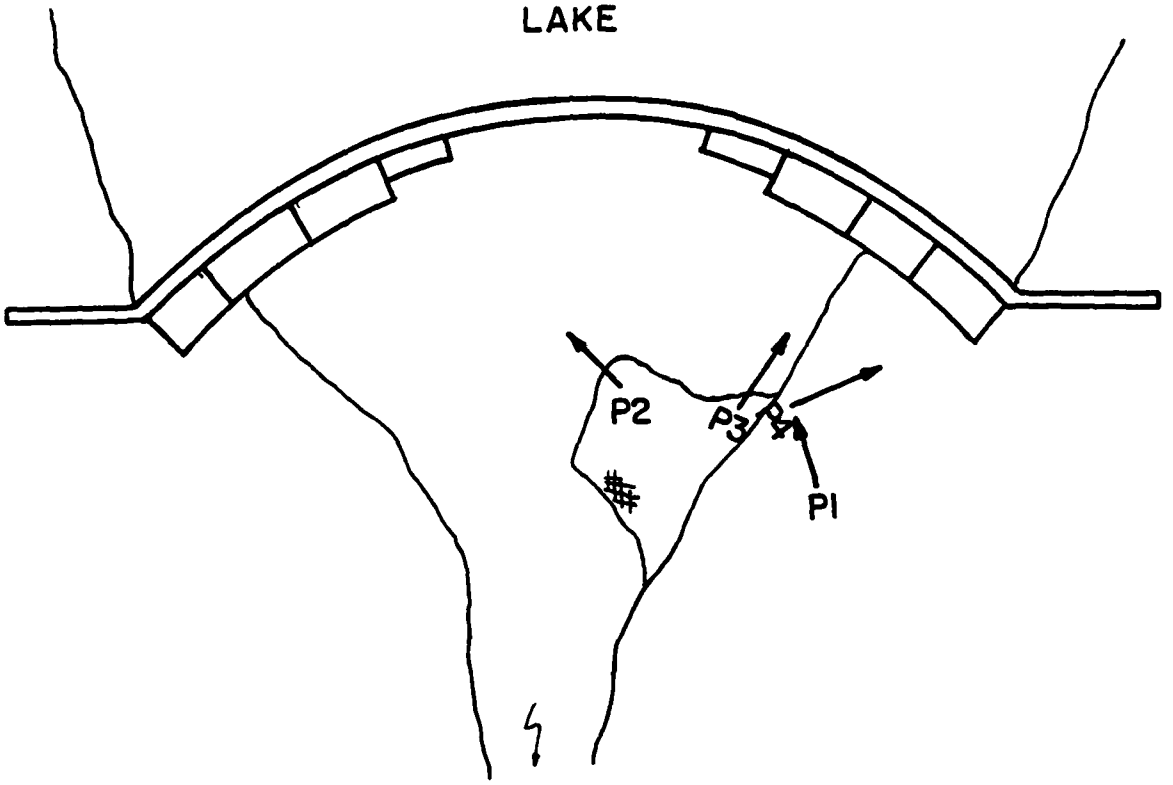
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	725.00	725.00	735.00
STORAGE	1185.	1185.	3406.
OUTFLOW	0.	0.	23376.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	732.33	0.00	2684.	14663.	0.00	43.25	0.00
.20	736.60	1.60	3883.	29781.	3.25	43.25	0.00
.30	739.83	4.83	4938.	45130.	5.50	43.25	0.00
.40	742.60	7.60	5953.	60345.	6.75	43.25	0.00
.50	745.10	10.10	6959.	75481.	8.00	43.25	0.00
1.00	755.52	20.52	12145.	150256.	12.50	43.25	0.00

BQ0JAXN. 79/09/17.EK31 175J.N0460.44A 79/09/16.DS-0 03.07.10. 79/09/17.

PHOTOGRAPHS

Photos 5 and 6 Eugene Nims' Dams
Upstream of Frederick City Dam



P - INDICATES PHOTO LOCATION

FREDERICKTOWN CITY DAM
PHOTO INDEX

Photograph No. 1

Downstream face of dam.

Photograph No. 2

Right abutment.

Photograph No. 3

Left abutment.

Photograph No. 4

Left abutment.

Photograph No. 5

S-F Scout Ranch Dam.

Photograph No. 6

S-F Scout Ranch Dam Spillway.